

with light frost as far south as Augusta, Ga. During the closing days of the month freezing temperature and snow occurred at Flagstaff, Ariz.

Warnings were issued well in advance of storms that threatened shipping on the seacoasts and Great Lakes, and ample and timely advices regarding frosts and freezing temperatures were distributed in sections where vegetation was subject to damage by cold.

The display of storm warnings on the Great Lakes was resumed for the season April 16, 1906.

#### BOSTON FORECAST DISTRICT.

The principal storm occurred on the 9th and 10th, when heavy precipitation occurred over a great part of New England. In Maine the precipitation fell as snow, which exceeded 6 inches in many sections of the State. Along the coast the storm was attended by easterly gales that caused considerable damage to shipping and to telegraph and telephone lines. Storm warnings are displayed in connection with this storm and also on the 14th and 24th. No gales occurred for which warnings were not displayed.—*J. W. Smith, District Forecaster.*

#### LOUISVILLE FORECAST DISTRICT.

Fine seasonable weather prevailed. Several thunderstorm periods were attended by moderate rains and more or less severe local storms. There were three warm periods and a like number of cool periods with frost. Special frost warnings issued on the mornings of the 16th and 23d were verified.—*F. J. Walz, District Forecaster.*

#### CHICAGO FORECAST DISTRICT.

Warnings were issued to open ports on Lake Michigan in connection with storms that reached the upper Lake region on the 9th and 14th. On the morning of the 25th warnings were issued to Lake ports for a storm that occupied the middle Missouri Valley. This storm was attended by thunder-squalls on Lakes Michigan and Superior.—*H. J. Cox, Professor and District Forecaster.*

#### NEW ORLEANS FORECAST DISTRICT.

No storm or cold-wave warnings were issued or required. Frost warnings were issued on the 13th for Oklahoma and on the 14th for Arkansas and were verified over portions of the area covered by the warnings. No frost occurred without warning.—*I. M. Cline, District Forecaster.*

#### DENVER FORECAST DISTRICT.

Unsettled weather predominated. Storms were not severe in the plains region, but in the mountain districts, especially in Colorado, heavy falls of snow were common. Light frost was noted on a number of dates, but owing to the backwardness of vegetation little or no damage resulted. No special warnings were issued or needed.—*F. H. Brandenburg, District Forecaster.*

#### SAN FRANCISCO AND PORTLAND FORECAST DISTRICTS.

Rain occurred in southern California on the 4th, 5th, and 6th, and in Nevada on the 11th, and rain was general in California and Nevada on the 10th, 22d, 27th, and 28th. In the North Pacific States and Idaho the month was warm and dry, the mean temperature at Portland, Oreg., being the highest on record for that station. Frost occurred frequently during the month and timely warnings were issued in connection therewith. Storm warnings were ordered well in advance of a storm that appeared off the Washington coast on the morning of the 8th.—*E. A. Beals, District Forecaster.*

#### RIVERS AND FLOODS.

At the close of the month of March, 1906, the Ohio and Mississippi rivers and their principal tributaries were rising rapidly, and by the second day of April a moderate flood was in progress in the Ohio River below the Big Sandy, the crest passing Cairo on the 9th. The stages from Cincinnati to Cairo were only slightly above the flood lines, except at Evansville

and Mount Vernon, Ind., where the water reached a height of a little over 41 feet on the 6th and 7th, about six feet above the flood stage. Along the Wabash and White rivers the flood was quite severe, with a stage at Mount Carmel, Ill., on the Wabash River, of 23.6 feet, 8.6 feet above the flood stage. A large area of bottom lands was overflowed, and in a few low-land sections the people were compelled to temporarily abandon their homes. The damage done was comparatively little, as the floods occurred sufficiently early to allow the bottoms to dry out fairly well before the full inauguration of the season of spring plowing. There was some damage done to growing wheat along the Wabash River, but its exact extent has not been ascertained.

The preliminary warnings for these floods were issued on March 28, and specific ones regularly thereafter until the waters began to recede.

The lower Mississippi flood also set in early, and the dates of reaching the flood stages at the various stations were as follows:

Station.	Flood stage.	Date.	Maximum stage.	Date.
New Madrid, Mo.	34	April 2	37.0	April 9-12
Luxora, Ark.	33	.....	31.3	April 14-15
Memphis, Tenn.	33	April 6	37.1	April 16
Helena, Ark.	42	April 8	47.0	April 18-19
Arkansas City, Ark.	42	April 5	50.0	April 22
Greenville, Miss.	42	April 14	44.9	April 23-24
Vicksburg, Miss.	45	April 17	47.2	April 26
Natchez, Miss.	46	April 24	46.7	April 29-30
Baton Rouge, La.	35	May 1	.....	.....
New Orleans, La.	16	April 20	.....	.....

At the end of the month the river was falling from Natchez northward, but was still rising slowly below.

The issue of flood warnings began over the Memphis district on March 31, and they were gradually extended southward at the proper times. The warnings were verified to almost absolute exactness, and, so far as has been ascertained, no serious damage was caused, nor was there any irreparable delay in planting. Many people were, of course, subjected to considerable expense and inconvenience, but such experiences are in a measure expected almost annually. The following report on the flood in the Memphis district was prepared by Mr. S. C. Emery, the official in charge of the local office of the Weather Bureau at Memphis, Tenn. The remarks of Mr. Emery as to the effects of recent levee construction, and his deductions from the changed gage relations between Cairo and Helena, are especially interesting and instructive.

The first important rise of the season had its beginning about March 1, and was caused by a series of heavy rains over the Missouri watershed, supplemented by a protracted period of local rains. After reaching nearly a bank-full stage about the middle of March, there occurred a slight decline, which was suddenly checked on March 24 by a sharp rise. This was caused by a Texas rainstorm that passed over the central valleys about that time, causing flood stages in many of the upper tributaries. These flood waters came mainly from the upper Mississippi, Ohio, and Cumberland rivers, and coming, as they did, into the lower stream with its already well-filled banks, at once gave promise of very high water throughout this district. Accordingly on March 31 warning messages and bulletins were extensively distributed over the threatened area; the inhabitants of the lowlands of Tennessee and Arkansas were notified that flood stages would soon prevail throughout the district, and that the river would be out of its banks in about seven days. Two days later a second warning bulletin was issued, in which the people were advised to prepare for stages as high as 38 feet at New Madrid, 37 feet at Memphis, and 47 feet at Helena. Considering the already swollen condition of the river, the rise was remarkably rapid, the daily increase ranging from two feet to about one-half foot from the beginning of the rise, on March 24, until the arrival of the flood crest, on April 14. On the latter date the river became practically stationary at Memphis, although the actual maximum occurred at noon of the 16th, when the gage marked 37.1 feet. The highest stage reached at New Madrid was 37 feet on April 9, and that at Helena, 47 feet on the 18th.

The river was above the danger line as follows: New Madrid from April 2 to 19, 18 days; at Memphis from April 6 to 24, 19 days; and at Helena from April 7 to 28, 21 days.

The region overflowed embraced all the bottom lands along the left bank of the Mississippi River from below Hickman, Ky., to a short distance above Memphis, most of the islands, and all of the Arkansas lands lying outside the protecting levee. The overflow caused no serious damage to property, or, as far as known, irreparable delay in planting. It necessarily caused very great inconvenience and considerable expense to the large number of people who were forced to abandon their homes and move live stock and other property to places of safety, but as, in some sections at least, these conditions have become somewhat of an annual occurrence, and as the people are in a measure prepared for such emergencies, the hardships in that connection were not excessive. All levee work was suspended, and a few of the camps of workmen were moved to higher ground.

As often as the mail facilities would permit, weather maps and river bulletins were sent to every town or settlement having a post office, and distributed along the river by passing boats. In this way nearly every one in the district was kept very well informed regarding the situation and also as to the prospects for the immediate future. As a result of the widespread distribution of river information there was very little excitement, and planters as a rule were able to control their negro help. Residents of Memphis having property interests in the overflowed district consulted with this office daily, and upon the advice given set about moving or otherwise protecting their property, or refrained from doing so as the exigencies of the case seemed to warrant.

The effect of the new extensions to the levee system has been the raising of the flood level in certain sections, notably at New Madrid and Helena. At the latter place, owing to the closing of an 18-mile gap in the levee south from Walnut Bend, which prevents the water from flowing out over the southeast portion of Lee County as it has done in previous years, the flood level has been raised about one and one-half feet; that is, with the same amount of water that obtained in 1903 and 1904 the gage at Helena may be expected to show about one and one-half feet more than was registered during the high water of those years.

The effect of the new levee along the south end of the basin is shown to some extent at Memphis and as far south as Mhoon's Landing, Miss. The additional restraint caused by the modified levee conditions has resulted in a slight engorgement, making the outflow somewhat less rapid, and retarding the arrival and passing of the flood crest at this place. In former years the crest of any rise was usually from two to three days in passing from Cairo to Memphis, while during the present high water the river at Memphis rose steadily for five days after a fall had set in at Cairo, and even on the seventh day a rise of two-tenths of a foot occurred, though the latter may possibly have been caused by the return waters from the Reelfoot bottoms, as was the case in 1903.

The usual flooding of North Memphis did not occur this year, on account of the recent construction of a high levee along the banks of Bayou Gayoso, which prevents the backwater in Wolf River from entering that portion of the city.

A change has also occurred in the gage relation between Cairo and New Madrid, Mo., the high-water level at the latter place having been raised nearly one foot since 1903. This is supposed to be due to the 4-mile extension recently made in the Reelfoot levee, which runs south from Hickman, Ky., to Tiptonville, Tenn., and fronts the Reelfoot bottoms. The object of this levee was to prevent the overflow waters from spreading through the lowlands in the northern portion of Lake County, Tenn., to Reelfoot Lake, from which place it passes through the marshes and small tributaries, entering the main stream several miles below New Madrid. About seven miles of the distance required to inclose the Reelfoot district is still open to the free passage of the overflow water, but in its incomplete state it has caused the increase at New Madrid noted above. When this levee has been completed, and the water is confined within narrower limits, we may expect the New Madrid gage to show a stage nearer approaching the Cairo reading than has heretofore obtained, as the waters that have formerly passed over and through the low country on the east side of the Mississippi will be thrown back to the Missouri shore.

The recent high water is of special interest at this time, as it is the first occurrence of such conditions since the completion of the St. Francis system of levees, which now extend from Point Pleasant, Mo., to the high ground near the mouth of the St. Francis River, a short distance above Helena, Ark., a total length of 207 miles. It was built jointly by the United States Government and the tax payers of Arkansas, at a cost to date of nearly \$4,000,000, and the present flood afforded the first successful test that has been given the levees since the completion of the entire system. It was in every way quite satisfactory. The water against the levees ranged in depth from 10 to 15 feet, and, while at no time were they considered in danger, they were given very close attention by the U. S. Engineers and Mississippi River Commission officials, a regular patrol being kept up over the entire line.

As an indication of the increasing confidence in the stability of the levee, even in its present state, it can be stated that the high water caused no interruption whatever to farm work or other operations throughout eastern Arkansas, except over those portions lying outside the levee. One could stand upon these great embankments, and see upon one side farmers busy at work planting their crops or engaged in other pursuits and on the other a wide expanse of water with no habitable spot visible as far as the eye could reach.

A very interesting fact in connection with the recent rise is that the highest stage at Memphis was only two-tenths of a foot below the maximum registered by the same gage during the great flood of 1897, when the St. Francis basin was completely inundated and a large number of its inhabitants were forced to leave their homes, to be cared for in refugee camps wherever such could be established.

Notwithstanding this similarity in the height of the wave crests at Memphis during the high water of 1897 and 1906, the records show that the maximum stage at Cairo in 1897 was nearly five feet higher than in 1906. This marked increase at Memphis is of course the result of confining the water to narrower limits, the full effect of which is now shown for the first time since the beginning of levee construction in this district in 1895.

It is now a well established fact that a stage at Cairo equal to that of 1883 (52.2 feet) would raise the water on the Memphis gage to 43 and possibly to 44 feet.

Nothing of interest occurred along the upper Mississippi, except in the vicinity of Hannibal, Mo., where the river was above the flood stage of 13 feet throughout the month, reaching a maximum stage of 15.2 on the 25th. The public was kept well informed of the steady rise, and but little damage resulted. Some unprotected bottom lands on both sides of the river were overflowed, and there was sufficient seepage through the Sny levee to somewhat delay farming operations on the lands behind.

The rivers of Alabama and eastern Mississippi which were generally above the flood stages at the beginning of the month, fell steadily after that time, reaching the normal low-water levels during the last days.

The annual rise of the Columbia River began on the 3d, an unusually early date. The extent of the rise and the possibility of severe floods depends, of course, upon the subsequent weather conditions, but the opinion appears to prevail that the melting snows from the mountains will supply all streams affected with at least an abundance of water for irrigation purposes. The following table shows the maximum stages at Portland, Oreg., resulting from the spring rises of the last thirty years, except those of 1877 and 1878:

Year.	Date.	Stage.
1876.....	June 24.....	28.2
1879.....	June 9.....	20.5
1880.....	July 1.....	27.3
1881.....	June 16.....	19.7
1882.....	June 14.....	26.2
1883.....	June 14.....	17.8
1884.....	June 14.....	22.2
1885.....	June 23.....	14.5
1886.....	June 9.....	20.0
1887.....	June 21.....	25.7
1888.....	June 18.....	18.2
1889.....	May 21.....	10.0
1890.....	May 20.....	21.1
1891.....	June 7.....	14.1
1892.....	June 24.....	19.3
1893.....	June 15.....	22.0
1894.....	June 7.....	33.0
1895.....	May 30.....	16.3
1896.....	June 23.....	23.8
1897.....	May 24.....	27.7
1898.....	June 19.....	20.7
1899.....	June 23.....	24.2
1900.....	May 20.....	17.8
1901.....	June 3.....	20.8
1902.....	June 4.....	20.8
1903.....	June 19.....	24.0
1904.....	June 27.....	20.8
1905.....	June 15.....	13.6

The highest and lowest water, mean stage, and monthly range at 309 river stations are given in Table VI. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—H. C. Frankenfeld, *Professor of Meteorology.*

NOTE.—The term, "danger line", will no longer be used in designating the overflow stages of rivers. As a substitute the words "flood stage", will be used, the term meaning the lowest stage of water at which overflow will begin.